The Incidence of Bovine Tuberculosis in Humans in Northern Ireland

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In 1901-1910 a Royal Commission established beyond doubt, by isolating the bovine bacillus from human lesions, that the bovine type was virulent for man. From then onwards the incidence of the bovine bacillus in human lesions has always been an indication of the efficacy of the supervision of the milk supply. The Ministry of Agriculture has always striven to reduce the bovine tuberculosis and thereby the dissemination of tubercle bacilli amongst the population. In Ayrshire, Jordan (1933) estimated that over a period of six years compensation for slaughtering tuberculous animals and the rejection of meat meant a loss to the country of about £750,000 per year. In spite of this, the bovine strain causes two thousand human deaths every year and is responsible for at least four thousand fresh cases annually. These cases have to be treated. And for this, expenses of sanatoria amount to about £500,000 per year. Thus the killing of cattle, the rejection of tuberculous meat, and the treatment of cases of human tuberculosis, in all cost the country one-and a-quarter-million pounds a year. The check on the incidence of bovine tuberculosis amongst humans is thereby essential in the interests of everybody. Such investigations have been carried out in Scotland and England, but never in Belfast. The findings below are the result of such investigation carried out in Belfast, Northern Ireland.

This work consisted in the isolation of strains of tubercle bacilli from specimens of tuberculous material chiefly derived from unselected cases of non-pulmonary tuberculosis. After the primary isolation, each strain was typed. The technique used was similar to that used by Griffith, Blacklock, and others.

If the specimen was uncontaminated and free of other organisms, as frequently in the case of cerebro-spinal fluid, and some urines, it was centrifugalised for twenty minutes at 3,000 in a sterile tube. The deposit was then spread over the surface of the media. However, when material contained extraneous cellular or amorphous material or was contaminated, as with pus from glands, sinus washings, stomach washings, urines, it was mixed and incubated with normal solution of sodium hydroxide. This destroyed contaminating organisms. After centrifugalisation the deposit was neutralised to litmus with eight per cent. hydrochloric acid and spread over the media. At least two tubes of media containing glycerine and two without glycerine were cultured. Early in this work Dorsets egg-media was used in isolation along with Lowenstein media, but finding the Lowenstein more satisfactory for isolation, the use of Dorsets was reserved for subculture and typing work.

The standards used in the recognition of the two types of the tubercle bacillus were based on the rate of growth, character of growth, the reaction of growth to

presence of glycerine, and the virulence of the bacillus for rabbits. The bovine type grew slowly, taking sometimes four to six weeks to appear, whereas the human type only required two to three weeks to produce the same amount of growth. The bovine type gave a finer and smoother growth, which in the early stages was smooth, moist, and clear, whilst the human strain produced a coarser granular dry growth which was sometimes pigmented. When glycerine was added to the media, the growth of the bovine strain was usually inhibited or unaffected, but a human type usually produced a more profuse growth in its presence. When injected into rabbits, a bovine strain produced generalised miliary lesions, whilst ten times the dose of a human culture only gave rise to localised lesions in lungs and in a few of the viscera (see figures 1 and 2). The typical bovine type, because of its poorer non-pigmented growth on glycerine, was labelled 'dysgonic,' and the human with its more profuse and pigmented growth was called 'eugonic.' Atypical strains have further been divided into eugonic bovine, dygonic human, and attenuated bovine and virulent human types.

A thorough investigation therefore means subcultural work and animal inoculation. In the following cases not all were inoculated into rabbits.

Tuberculous Meningitis.

Twenty-five strains: Cerebro-spinal fluid taken from thirty-two patients was examined for the presence of tubercle bacilli by direct examination of a smear of the deposit and by culture of the deposit. Of these, twenty-nine died from tuberculous meningitis, the other three recovered and were not proven to be of tuberculous origin. Twenty-five of the fatal cases gave positive cultural results, and in some of these, those on whom autopsy was done, strains were isolated from tuberculous lung-tissue, hilar or mesenteric glands, or other caseous material. In all instances these strains were identical with those obtained from the ante-mortem spinal fluid. No strains were obtained from cases which recovered from the disease. Some of the cases are worthy of a short description of their interesting features.

C.1.—This was a man aged 35 years who had a primary pulmonary focus in the right upper lobe. This had healed. There was a tuberculous osteitis of the bodies of the thoraco-lumbar vertebræ, psoas abscesses, and epidural abscesses along the spinal canal. This had involved the dura mater and spread through it and produced a tuberculous meningitis. The maximum exudate in this case was on the basal surface of the brain. The tubercle bacilli isolated from the spinal fluid ante-mortem, and post-mortem from psoas pus, were of the eugonic human type. This was an example of how a caseous involvement of the dura mater in the spinal canal may also spread to the arachnoid and set up a tuberculous meningitis.

C.8 was the first dysgonic bovine strain isolated in this series. It was derived from the fluid of a boy aged one year and three months who died after four weeks' illness. This strain appeared as small clear colonies about pinhead size on Lowenstein medium after forty days. Thus after almost six weeks a growth became easily visible to the naked eye. The media in this case contained glycerine. The length of time necessary to produce visible growth was the striking feature about this dysgonic strain.

C.11.—This was the case of a fatal tuberculous meningitis due to the eugonic human type occurring in a breast-fed female child aged two months. The family history gave a clue to the possible source—an uncle who was often in close contact with the child was admitted to another hospital suffering from acute pulmonary tuberculosis and had a positive sputum. This is the youngest case in the series, and it emphasises the need for earlier detection of the cases with positive sputa, say by miniature radiography. In many of these cases spread occurred from advanced cases usually undiagnosed till later or from inadequately treated patients.

C.13 was a bovine strain which was isolated from the fluid from a girl aged 14 years taken on the sixteenth day of illness. This strain was a dysgonic bovine one and was similar in behaviour to a strain isolated at post-mortem. Autopsy showed a primary tuberculous complex in the mesenteric glands. There was no family history of tuberculosis.

C.16 turned out to be a dysgonic bovine strain, and came from the spinal fluid which was taken from a ten-year-old girl on the sixth day of her fatal illness. This girl, one month before the outset of the meningitis, had been admitted to hospital with the history of having had attacks of abdominal pain, occasional vomiting, and tenderness in the right iliac fossa for the previous two months. She was found to have palpable mesenteric glands, a positive mantoux test, and nothing definite in a barium meal X-ray films. The appendix was surgically removed, and found to be short and straight. The mesenteric glands were enlarged. Post-operatively she had a temperature of 103° for a few days, but was discharged symptomless after ten days in hospital. About three weeks later she was re-admitted on the sixth day of a similar type of illness. However, drowsiness and irritability became marked, and the diagnosis of tuberculous meningitis was made. She was removed from hospital contrary to medical advice, and autopsy was not carried out. Findings at operation suggested a primary abdominal tuberculous complex, but whether the surgical interference precipitated a blood-spread to the meninges or not could not be proven.

C.22 was a strain which came from the fluid of a boy aged seven years. This was a eugonic human strain. Autopsy displayed the probable sequence of events as a primary pulmonary tuberculous complex, tuberculous pneumonia, enteritis, mesenteric and hilar adenitis, and tuberculous meningitis. The pulmonary lesion was extensive, but so also was the ulceration of the small intestine and the enlargement and caseation of the mesenteric lymph-glands. The involvement of the latter was so much that it resembled a primary complex. This suggested the possibility of perhaps a mixed infection. The isolation, however, of a strain from the abdominal glands and one from hilar glands, both of which resembled the eugonic human strain recovered from the cerebro-spinal fluid before death, did not confirm this. Only the meningeal strain was inoculated into a rabbit.

The Types of the Bacilli Isolated.

By culture on solid media, twenty-five strains of tubercle bacilli were isolated from the cerebro - spinal fluids of twenty - nine cases of tuberculous meningitis.

Eighteen of these strains turned out to be eugonic on subculturing, and were found to be of low virulence on intravenous injection into rabbits. Thus eighteen were eugonic-human-type strains. The other seven isolated were highly virulent to rabbits, possessed dysgonic characteristics, and were therefore labelled dysgonic bovine strains: so seven out of twenty-five, or twenty-eight per cent., of strains from meningitis were bovine type. Other workers in England and Scotland have found varied results.

	Per Cent. Bovine	Region
Griffith ... ... (1919)	16.0	
Griffith ... ... (1929)	21.8	
Griffith and Munro ... ... (1932)	13.3	Scotland
Griffith ... ... (1934)	21.8	England (151)
	40.5	Scotland (37)
MacGregor, Kirkpatrick, and Craig (1935)	28.0	Edinburgh
Saenz ... ... (1938)	5.4	France
(1940)	28.0	Belfast

Thus it is seen that the incidence of bovine tubercle bacilli in Belfast is the same as in Edinburgh. This is reasonable, because of the similarity in size and milk supply in both places. The figure is lower than that for Scotland, possibly because of the greater incidence of rural cases in the Scottish investigation, and higher than the figure for the industrial centres of England.

TUBERCULOUS MENINGITIS.

Locality	Cases	Human	Bovine	% Bovine
Aberdeen	15	8	7	47
Newcastle-upon-Tyne	13	13	0	0
Sheffield	9	6	3	33.3
Liverpool	10	8	2	20
Bristol	5	4	1	20
Edinburgh (Macgregor) ...	80	61	19	24
Belfast	25	18	7	28

The age of the patients varied from two months to thirty-five years; twenty were under fifteen years old. From these, twenty-seven cerebro-spinal fluids gave the bovine type of tubercle bacillus. Thus of those under fourteen years, thirty-seven per cent. were due to bovine bacilli. Griffith (1929) found a corresponding incidence of thirty-four per cent. bovine.

Of the twenty-five cases, fourteen were males, and these gave three bovine type strains. Just more than half (fifty-five per cent.) of those under fifteen were boys—almost the same figure as Blacklock and Griffin (1935) found. From these eleven boys, three bovine strains were grown. The nine girls under fifteen had bovine bacilli in four of them.

The primary complex of infection was determined clinically or after some of the cases had been examined post-mortem. The site of entry of the tubercle bacillus in five—the dysgonic-bovine cases (8, 13, 15, 16, 17)—was in mesenteric complex. The other two cases were not investigated sufficiently to localise the primary tuberculous complex. Of the remaining eighteen eugonic-human strains, in fourteen there was definitely a primary thoracic lesion, and in the other four a probable

pulmonary complex. Thus out of nineteen cases satisfactorily examined, fourteen were originated in primary thoracic lesions—seventy-three per cent. This is higher than Macgregor and Alexander (1936) found in 333 cases, their figure being sixty per cent. It approximates that of Blacklock and Griffin (1935), however, who calculated the incidence to be 73.9 per cent. in 241 cases of tuberculous meningitis autopsies. They cite higher figures—96.4 per cent. of fifty-five cases by Wangenheim (1928), one hundred per cent. of fifty-four cases by De Villa Genoese (1924).

Primary Cervical Tuberculous Adenitis.

Twelve strains: This has been investigated in sixteen instances with the isolation of twelve strains of tubercle bacilli. Of these twelve, two cultures were bovine in type—a bovine incidence of about 16½ per cent. One of the bovine strains was obtained from a swab: cultures grew both from the medium, which was rubbed with the swab, and from that which received debris from the swab after it had been treated with alkali and neutralised. This child drank milk received from a local country farmer.

Admittedly the number of cases investigated is small, but it is a definite indication that the bovine bacillus is a potential infecting source in and around Belfast. The figures are much lower than others, possibly because milk is more strictly supervised and satisfactorily produced than it was in 1932 or 1929. Probably if figures were made now of those districts, the bovine bacillus might not be so commonly found.

Genito-Urinary Tuberculosis.

Cases of tuberculosis of kidneys, bladder, seminal vesicles, and epididymis were investigated in twenty-two strains. From these, three were dysgonic-bovine strains —an incidence of 16.6 per cent.

Tubercle bacilli were seen on direct smear in fifteen of those eighteen cultured, and in two cases which did not give a positive culture. Only two cases were under fourteen years old, and of these one gave a bovine strain.

CERVICAL ADENITIS.

Strain	Sex	Age	Specimen	Examination Direct	Culture	Cultural Type
A13	F	2 1/12	Pus	Pos.	Pos.	Eugonic human
A20	F	6	Pus	Pos.	Neg.	—
A32	M	12	Pus & gland	Pos.	Neg.	—
A33	M	39	Gland	Neg.	Neg.	—
A37	F	36	Pus	Pos.	Neg.	—
A41	M	1½	Pus	Neg.	Pos.	Eugonic human
A43	F	56	Pus	Pos.	Pos.	Eugonic human
A48	F	16	Pus	Pos.	Pos.	Eugonic human
A54	M	1 3/12	Pus	Pos.	Pos.	Eugonic human
A61	F	6½	Pus	Pos.	Pos.	Eugonic human
A69	M	10	Pus	Neg.	Pos.	Eugonic human
A72	F	31	Glands	Neg.	Pos.	Eugonic human
A74	F	6	Swab	Pos.	Pos.	Dysgonic bovine
A99	F	9	Gland	Pos.	Pos.	Dysgonic bovine
A104	F	19	Pus	Neg.	Pos.	Eugonic human
A105	F	20	Pus	Neg.	Pos.	Eugonic human

Thus in twelve strains from all ages 16.6 per cent. were bovine: in eleven from patients under sixteen years, two, or eighteen per cent., were bovine. The incidence varies very much in districts. Corresponding figures are:—

Munro in Scotland	6 per cent.	
Griffith (1929)	70 „ „	Scottish
Griffith	60 „ „	English
Blacklock (1932)	64 „ „	English
Saenz	1.4 „ „	(France)
Belfast (1940)	16.6 „ „	

The bovine incidence in Belfast corresponds closely to Giffith's figure (1929) of 17.4, when he found four of that type amongst twenty-three strains. Alston and Griffith found in forty-two strains, thirteen of the bovine type—30.9 per cent.

Bone and Joint Tuberculosis.

Seventeen cases were investigated, varying in character from a mastoiditis at the age of two months to a wrist-joint disease at seventy-four years. This resulted in the isolation of strains of bacilli in twelve cases; of these, two were regarded as bovine in type (A52 and A56)—16½ per cent. One case (A21) did not clinically resemble tuberculosis, and gave negative results direct and on culture. So out of sixteen cases of tuberculosis, twelve gave positive cultures, and in these twelve, six showed bacilli on direct examination. Two cases positive direct did not grow on culture.

BONE AND JOINT TUBERCULOSIS.

Strain	Sex	Age	Localisation	Specimen	Direct	Type
A1	M	16	Hip-joint	Pus	Pos.	Eugonic human
A7	F	2/12	Mastoiditis	Sequestrum	Pos.	—
A21	F	9	Elbow-joint ...	Pus	Neg.	—
A22	M	21	Knee-joint	Inguinal gland	Neg.	Eugonic human
A36	M	20	Knee-joint	Pus	Neg.	Eugonic human
A52	M	2	Mastoid, skull, phalanges ...	Pus	Pos.	Dysgonic bovine
A56	M	56	Hip-joint	Pus	Pos.	Dysgonic bovine
A62	F	18	Ankle-joint ...	Pus	Neg.	Eugonic human
A63	F	74	Wrist-joint ...	Pus	Pos.	Eugonic human
A65	F	40	Vertebræ	Urine	Pos.	Eugonic human
A68	M	50	Elbow-joint ...	Pus	Pos.	Eugonic human
A81	M	56	Ankle-joint ...	Pus	Neg.	—
A90	M	65	Vertebræ	Pus	Pos.	—
A97	F	22	Saciccliac joint ...	Sinus washing	Neg.	—
A103	M	23	Hip-joint	Pus	Neg.	Eugonic human
A106	M	27	Knee-joint	Pus	Neg.	Eugonic human
A107	F	34	Ankle	Pus	Neg.	Eugonic human

In Belfast, therefore, the incidence of the bovine strain is about 16½ per cent. in

TABLE 1.

POSITIVE RESULTS.

No.	Sex	Age	Lesions	Source of Infection	Specimen	Direct	Type	
							Culture	Virulence
C1	M	35	Healed pulmonary; vertebral osteitis; epidural abscess; T.B. meningitis (T.M.) ...	?	C.S.F.	Pos.	Eugonic	Human
C3	F	10	Pulmonary, miliary, T.M. ...	?	Pus	Pos.	Eugonic	—
C4	M	14	Pulmonary T.M.	Family history denied	C.S.F.	Pos.	Eugonic	Human
C5	M	10	Pulmonary T.M.	Parental	C.S.F.	Neg.	Eugonic	Human
C6	M	7	?Pulmonary hip-joint ...	Parental	C.S.F.	Neg.	Eugonic	Human
C8	M	1¼	?Abdominal T.M.	Parental ?	C.S.F.	Neg.	Eugonic	Human
C9	M	19	Pulmonary T.M.	Unknown	C.S.F.	Pos.	Dysgonic	Bovine
C10	M	10½	?Pulmonary T.M.	? Family	C.S.F.	Pos.	Eugonic	Human
C11	F	2/12	Pulmonary T.M.	? Family	C.S.F.	Pos.	Eugonic	Human
C12	F	5½	?Pulmonary T.M.	Family	C.S.F.	Pos.	Eugonic	Human
C13	F	14	Abdominal, miliary T.M. ...	?	C.S.F.	Pos.	Dysgonic	Bovine
				Milk	P.M. C.S.F.	Pos.	Dysgonic	—
					Gland	Pos.	Dysgonic	—
C14	M	19	Pulmonary T.M.	?	C.S.F.	Pos.	Eugonic	Human
C15	M	1¾	Mesenteric T.M.	Milk	C.S.F.	Pos.	Dysgonic	Bovine
C16	F	10	(Primary) abdominal T.M....	?	C.S.F.	Pos.	Dysgonic	Bovine
C17	F	10	Mesenteric T.M.	Milk	C.S.F.	Pos.	Dysgonic	Bovine
C18	F	19	Mesenteric T.M.	?	C.S.F.	Pos.	Eugonic	Human
C19	M	13	?Primary T.M.	?	C.S.F.	Pos.	Dysgonic	Bovine
C20	M	7	Pulmonary T.M.	Family negative	C.S.F.	Pos.	Eugonic	Human
C21	F	9	T.M.	?	C.S.F.	Pos.	Dysgonic	Bovine
C22	M	7	Pulmonary, secondary mesenteric T.M.	Family history	C.S.F.	Pos.	Eugonic	Human
				±	(P.M. gland),	Pos.	Eugonic	—
					hilar, abd.	Pos.	Eugonic	—
C23	F	6	?Pulmonary T.M.	Family	C.S.F.	Pos.	Eugonic	? Human
C24	M	3	Pulmonary T.M.	Family	C.S.F.	Neg.	Eugonic	Human
C27	M	12	Pulmonary T.M.	Family	C.S.F.	Pos.	Eugonic	Human
C29	F	2	Pulmonary T.M.	?	C.S.F.	Pos.	Eugonic	Human
C30	F	19	Pulmonary T.M.	Family	C.S.F.	Pos.	Eugonic	Human

TABLE 2.

NEGATIVE RESULTS.

CASE	SEX	AGE	LESIONS	SPECIMEN	DIRECT	CULTURE	REMARKS
C2	F	3	Mastoiditis, meningeal irritation ...	Sequestrum C.S.F.	Pos. Neg.	Neg. Neg.	—— Not T.M.
C7	M	8	Tuberculous meningitis ...	C.S.F.	Neg.	Neg.	Removed from hospital C.T.A.
C25	M	24	Pulmonary T.M.	C.S.F.	Pos.	Neg.	——
C26	F	57	Pulmonary T.M.	C.S.F.	Pos.	Neg.	——
C28	F	4	P.U.O., meningeal irritation	C.S.F.	Neg.	Neg.	No tuberculosis in a guinea-pig
C31	F		T.M. & primary unknown	C.S.F.	Pos.	Neg.	——
C32	F	12	Lymphatic meningitis ...	C.S.F.	Neg.	Neg.	No lesions in a guinea-pig

TABLE 3.

GENITO-URINARY TUBERCULOSIS.

STRAIN	SEX	AGE	LOCALISATION OF DISEASE	SPECIMEN	MICROSCOPICAL EXAMINATION	CULTURE	CULTURAL TYPE
A3	F	43	Cystitis	C.S.U.	Pos.	Pos.	Eugonic human
A5	F	30	Renal	C.S.U.	Pos.	Pos.	Eugonic human
A14	M	12½	Renal	C.S.U.	Pos.	Pos.	Eugonic human
A17	M	36	Renal	C.S.U.	Pos.	Pos.	Eugonic human
A23	M	23	Renal	C.S.U.	Pos.	Pos.	Eugonic human
A25	F	29	Bilateral renal	C.S.U.	Pos.	Pos.	Eugonic human
A26	M	36	Seminal vesicle	Urine	Neg.	Pos.	Eugonic human
A27	F	32	Renal	Urine	Pos.	Pos.	Eugonic human
A29	M	21	Renal	Urine	Pos.	Pos.	Eugonic human
A30	M	30	Epididymitis	Pus	Pos.	Pos.	Eugonic human
A34	M	9	Renal	Urine	Pos.	Pos.	Dysgonic bovine
A40	M	29	Renal	Urine	Neg.	Pos.	Eugonic human
A44	M	18	Renal	Urine	Pos.	Pos.	Eugonic human
A56	M	30	Epididymitis	Pus	Pos.	Pos.	Eugonic human
A83	M	19	Renal	Kidney	Pos.	Pos.	Eugonic human
A88	F	21	Renal	Pus	Pos.	Pos.	Dysgonic bovine
A93	F	25	Cystitis	C.S.U.	Pos.	Nil	—
A94	F	66	Renal	C.S.U.	Pos.	Nil	—
A95	M	33	Renal	C.S.U.	Pos.	Pos.	Eugonic
A100	M	32	Renal	C.S.U.	Neg.	Neg.	—
A102	M	13	Renal	C.S.U.	Neg.	Neg.	—
A108	M	19	Renal	C.S.U.	Neg.	Pos.	Eugonic human

bone and joint tuberculosis. Corresponding figures elsewhere show much variation :

Griffith ... ... (1929)	26	per cent.	England } all ages
	18	„ „	Scotland }
Blacklock ... ... (1932)	34	„ „	
Griffith and Munro (1932)	66.7	„ „	East Scotland (under 15)
Fraser ... ... (1912)	61.2	„ „	Edinburgh
Miller ... ... (1937)	10	„ „	
Belfast ... ... (1940)	16½	„ „	

Miscellaneous.

Only five sputa were examined : in all of them bacilli were seen direct, and were grown on culture. All of these were eugonic-human strains.

Commentary.

From eighty-eight specimens strains of tubercle bacilli were grown from seventy-two, and of these seventy-two, the bovine type was present in fourteen of them.

	No. Cases	Direct Positive	Cultures	Bovine	% Bovine
Meningitis	29	25	25	7	28
Cervical	16	10	12	2	16½
Genito-urinary	22	17	18	3	16½
Bone and joint	16	8	12	2	16½
Pulmonary	5	5	5	...	0
	88	65	72	14	19.4

Thus about eighty per cent. of the tuberculous specimens yielded bacilli on culture. This is somewhat higher than Blacklock's figure (1932), using guinea-pigs. Seventy-two strains produced fourteen of bovine type, or a proportion of 19.4 per cent. Relative figures for other districts are best appreciated in tabular form.

PERCENTAGE BOVINE.

Source	Tuberculous Meningitis	Cervical Adenitis	Genito-Urinary	Bone and Joint	Pulmonary
Griffith					
English	27.3	45.7	17.4	18.2	—
Scottish	40.5	70.6	30.9	26.6	—
Blacklock					
Scottish	49.1	64.3	—	34.6	2.7
Saenz					
French	5.4	14.0	1.1	0	½
Belfast					
Northern Irish	28.0	16.6	16.6	16.6	—

The finding of 19.4 per cent. of bovine tubercle bacilli in Belfast suggests that milk dissemination of the bacilli is still high. Thus the typing of the tubercle bacillus is a final check on the efficacy of the control of tuberculosis in milking cows.

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A NATIONAL HOSPITAL SERVICE

A BOOKLET with the above title has been received from Mr. D. Lindsay Keir, vice-chancellor of the Queen's University. It is described on the cover as "A Memorandum on the Regionalisation of Hospital Services." It was published in July by the Nuffield Provincial Hospitals Trust, of which the vice-chancellor is one of the governing trustees.

The objects of the Trust and the progress made during the eighteen months of its existence are set forth in some detail. Interesting memoranda are included on (a) General Medical and Hospital Policy, (b) Accident Services, (c) Pathological Services.

We are reminded that "the development of organised medical services has been delayed by the lack of any regional hospital scheme in the past, with the result that progress in medical knowledge and skill has outrun any measures taken for their widespread application."

The booklet, which is now in the library, will be of special interest to those who attended the lecture given in April in the Whitla Medical Institute by Sir Farquhar Buzzard, chairman of the Medical Advisory Council of the Trust.

Fig. 1

Rabbit—received 0.1 mgm. human strain. Killed ninety days later. Note: localised lesions in lungs, few small foci in kidney and liver.

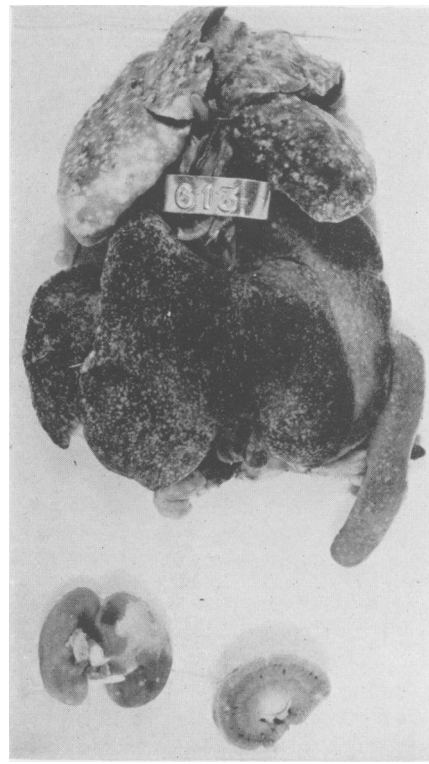

Fig. 2

Rabbit — received 0.01 mgm. bovine strain. Died forty days later.
Note: Generalised miliary lesions in all organs.